

## CLAIMS

1. Method for the contactless detection of flat objects, particularly in sheet form, such as paper, foils, films, plates and similar flat materials or packages, with respect to single, missing or multiple sheets of the flat objects, the flat objects being placed in the beam path of at least one transmitter and an associated receiver of a sensor device and in which the radiation transmitted through the flat objects or the radiation received by the receiver in the case of a missing sheet in the form of a measuring signal ( $U_M$ ) and said measuring signal ( $U_M$ ) are supplied to a following evaluation for generating a corresponding detection signal, characterized in that at least one correction characteristic (KK) is provided for evaluation, the correction characteristic (KK) transforms the characteristic of the input voltage ( $U_E$ ,  $U_M$ ) of measuring signal ( $U_M$ ) from receiver (R) as a function of the gram weight or weight per unit area of the flat objects (2) to the target characteristic (ZK), that for papers and similar materials a linear, approximately linear characteristic or a characteristic approaching the ideal single sheet characteristic is obtained as a target characteristic between the output voltage ( $U_A$ ,  $U_Z$ ) at the evaluation output and gram weight or weight per unit area in order to generate the corresponding detection signal.

2. Method according to claim 1, characterized in that the correction characteristic (KK) for papers and similar materials is derived from a characteristic of the input voltage ( $U_E$ ,  $U_M$ ) of the measuring signal mirrored on the ideal or approximated target characteristic (ZK) for single sheet detection.

3. Method according to claim 1, characterized in that the correction characteristics for papers and similar materials is derived from a target characteristic approximated to the ideal target characteristic of the single sheet following cartesian coordinate transformation with respect to the line linking the two end points of the measuring value characteristic for the material spectrum to be detected mirroring the characteristic of the input voltage ( $U_E$ ,  $U_M$ ) of the measuring signal.

4. Method according to one of the claims 1 to 3, characterized in that a constant target characteristic with a gradient of approximately 0 is selected as the ideal target characteristic (ZK).

5. Method according to one of the claims 1 to 4, characterized in that by means of the correction characteristic the characteristic of the input voltage ( $U_E$ ,  $U_M$ ) of the measuring signal is transformed into the target characteristic over a wide gram weight or weight per unit area range, particularly between 8 and 4000 g/m<sup>2</sup>.

6. Method for the contactless detection of flat objects, particularly in sheet form, such as multilaminated materials adhesively applied to base or support material, e.g. labels, splices, break or tear-off points and similar flat materials, with respect to the presence or absence, the flat objects being placed in the beam path between a transmitter and an associated receiver of a sensor device, the radiation transmitted through the flat objects or the radiation received in the case of an absence by the receiver is received as the measuring signal ( $U_M$ ) and the measuring signal ( $U_M$ ) is supplied to a following evaluation for generating a corresponding detection signal, characterized in that at least one

correction characteristic (KK) is supplied to the evaluation, that the correction characteristic (KK) transforms the characteristic of the input voltage ( $U_E$ ,  $U_M$ ) of the measuring signal ( $U_M$ ) from receiver (R) as a function of the gram weight or weight per unit area of the flat objects (2) to the target characteristic (ZK), that a linear or almost linear characteristic with finite gradient, particularly a characteristic provided in the gram weight range to be detected with a maximum gradient is obtained as an ideal target characteristic (ZK) or a target characteristic approximated to said ideal target characteristic between the output voltage ( $U_A$ ,  $U_Z$ ) at the output of the evaluation and the gram weight or weight per unit area, for generating the corresponding detection signal.

7. Method according to claim 6, characterized in that the correction characteristic (KK) for labels and similar materials is derived from the characteristic of the input voltage ( $U_E$ ,  $U_M$ ) of the measuring signal, which is mirrored on the ideal label detection characteristic (ZK) in the gram weight or weight per unit area range to be detected.

8. Method according to claim 6, characterized in that the correction characteristic (KK) for labels and similar materials is derived from the characteristic of the input voltage ( $U_E$ ,  $U_M$ ) of the measuring signal, which is mirrored on the ideal label detection characteristic (ZK) in the gram weight or weight per unit area range to be detected following cartesian coordinate transformation relative to the connecting line of the two end points of the measuring value characteristic for the material spectrum to be detected.

9. Method according to one of the claims 6 to 8, characterized in that in the case of labels, by means of the correction characteristic (KK) the characteristic of the input voltage ( $U_E$ ,  $U_M$ ) of the measuring signal is transformed to the target characteristic (ZK) over the gram weight or weight per unit area range to be detected, e.g. approximately 40 to 300 g/m<sup>2</sup>.

10. Method according to one of the claims 6 to 9, characterized in that the correction characteristic (KK) is chosen in such a way that a target characteristic (ZK) is obtained with a maximum, constant negative gradient and maximum voltage difference over the gram weight or weight per unit area range to be detected, e.g. from approximately 40 to 300 g/m<sup>2</sup>.

11. Method according to one of the claims 1 to 10, characterized in that the evaluation, particularly the measuring signal amplitude is performed at least over one signal amplification, that the signal amplification is supplied with at least one correction characteristic in such a way that at the signal amplification output the target characteristic for generating the detection signal is obtained.

12. Method according to one of the claims 1 to 11, characterized in that analog signals of an analog-digital conversion received in the receiver with subsequent or direct digital rating are subject to at least one correction characteristic for generating the corresponding detection signal.

13. Method according to one of the claims 1 to 12, characterized in that as flat objects also cardboard in sheet form, corrugated board or stackable packages are placed in the beam path between transmitter and receiver.

14. Method according to one of the claims 1 to 13, characterized in that the correction characteristic is impressed as a single characteristic or as a continuous or zonal combination of several different correction characteristics over the entire gram weight or weight per unit area range or portions thereof.

15. Method according to one of the claims 1 to 14, characterized in that the correction characteristic is supplied as a linear or nonlinear characteristic, as a single or multiple logarithmic characteristic, as an exponential characteristic, as a hyperbolic characteristic, as a polygonal line, as a random degree function, or as an empirically determined or calculated characteristic, or as a combination of several of these characteristics.

16. Method according to one of the claims 1 to 14, characterized in that the correction characteristic is impressed as a combination of linear and logarithmic, linear and two or multiple logarithmic or nonlinear and logarithmic or multiple logarithmic characteristics or amplification.

17. Method according to one of the claims 1 to 15, characterized in that the correction characteristic is given as a logarithmic or multiple logarithmic or similar nonlinear characteristic combined with an approximately linear or an exponentially or similarly rising characteristic or amplification.

18. Method according to claim 1, characterized in that as a correction characteristic for papers and similar materials use is made of a suitable characteristic for obtaining the ideal or approximately ideal target characteristic, particularly an inverse or almost inverse characteristic to the characteristic of the measuring signal input voltage ( $U_E$ ,  $U_M$ ).

19. Method according to one of the claims 1 to 18, characterized in that the given correction characteristic is fixed impressed or actively controlled or regulated.

20. Method according to one of the claims 1 to 19, characterized in that with respect to the single, missing or multiple sheet, at least two thresholds are given as the upper and lower threshold and in the case of the incoming measuring signal being larger than the upper threshold, it is evaluated as a "missing sheet", when the incoming measuring signal is between the thresholds this is evaluated as a "single sheet" and when the incoming measuring signal is smaller than the lower threshold, this is evaluated as a "multiple sheet".

21. Method according to one of the claims 1 to 19, characterized in that relative to labels, splices and break points and tear-off threads there is at least one detection threshold, on passing below said detection threshold this is evaluated as a "multiple layer" and on exceeding the detection threshold it is evaluated as a "support material or a multiple layer reduced by at least one layer".

22. Method according to one of the claims 1 to 21, characterized in that the thresholds, particularly the detection threshold or the threshold for multiple sheets, is set in fixed manner or designed so as to be dynamically carried along.

23. Method according to one of the claims 1 to 22, characterized in that the correction characteristic is determined as a function of the object and material-specific transmission attenuation and/or the resulting measuring signal voltage as a function of the gram weight or weight per unit area and that from this determination takes place either mathematically and/or empirically of the optimum correction characteristic or the optimum correction characteristic for the ideal target characteristic of the material-specific single sheet.

24. Method according to one of the claims 1 to 23, characterized in that the correction characteristic for several areas of material spectra is subdivided into several sections or several different section correction characteristics.

25. Method according to claim 16, characterized in that three or more sections are provided and associated with different gram weight or weight per unit area ranges.

26. Method according to one of the claims 1 to 25, characterized in that at least one ultrasonic sensor or one or more optical, capacitive or inductive sensors are used as the sensor device.

27. Method according to one of the claims 1 to 26, characterized in that the transmitter (T) and receiver (R) of the sensor device (10) are oriented with respect to one another in the main beam axis of the radiation used and in particular coaxially and that the main beam axis is oriented substantially perpendicular or under an angle to the plane of the flat objects moved between the transmitter (T) and the receiver (R) or moved relative thereto.

28. Method according to one of the claims 1 to 27, characterized in that the sensor device (10) is operated in particular in switchable manner, in pulsed operation or continuous operation.

29. Method according to claim 28, characterized in that in continuous operation of the sensor device (10) phase jumps and/or short interruptions of the transmitting signal are provided to prevent standing waves and/or interferences.

30. Method according to one of the claims 1 to 28, characterized in that the transmitting signal of transmitter (T) is frequency-modulated.

31. Method according to one of the claims 1 to 30, characterized in that, particularly for ultrasonics, transmitter (T) and receiver (R) are standardized pairwise to an optimum assembly spacing and that tolerances of the transmitter and receiver are automatically corrected at the start and/or during continuous operation.



32. Method according to one of the claims 1 to 31, characterized in that as a function of application and arrangement criteria transmitter and receiver for ultrasonic sensors are installed with variable spacing.

33. Method according to one of the claims 1 to 32, characterized in that the spacing between the transmitter and receiver is determined by reflection of the radiation used between transmitter and receiver, particularly when attenuating sheet material is positioned between them and that on rising above or dropping below the permitted spacings a fault announcement or indication is provided, particularly by LED.

34. Method according to one of the claims 1 to 33, characterized in that for the detection of single-corrugation or multiple-corrugation corrugated board and/or the conveying direction thereof, the sensor axis is placed between the transmitter and receiver of at least one sensor so as to be inclined to the perpendicular of the corrugated board sheet and in particular orthogonally to the widest surface of the corrugated board corrugation.

35. Method according to one of the claims 1 to 34, characterized in that a feedback for maximizing the amplitude of the measuring signal received is performed between the evaluating device and the transmitter.

36. Method according to one of the claims 1 to 35, characterized in that for digitizing the analog measuring signal use is made of at least one A/D converter and/or a threshold generator and/or use is made of a time multiplex method for selecting the different signals

of the signal amplifying devices.

37. Device for the contactless detection of flat objects, particularly in sheet form such as paper, foils, films, plates and similar flat materials or packs, with respect to single, missing or multiple sheets of the flat objects, having at least one sensor device (10) with at least one transmitter (T) and associated receiver (R), the flat objects to be detected being placed in the beam path between transmitter (T) and receiver (R), the receiver (R) receiving as a measuring signal the radiation transmitted through the flat objects or the radiation obtained in the case of a missing sheet and with a downstream evaluating device (4) to which the measuring signal ( $U_M$ ,  $U_E$ ) is supplied for generating a detection signal, particularly for performing the method according to one of the claims 1 to 36, characterized in that to the evaluating device (4) connected to the receiver (R) is supplied at least one correction characteristic (KK) in such a way that the correction characteristic (KK) transforms the characteristic of the input voltage ( $U_E$ ,  $U_M$ ) of the measuring signal from receiver (R) as a function of the gram weight or weight per unit area of the flat objects so as to give the target characteristic (ZK), that for papers and similar materials it is possible to produce a linear, approximately linear characteristic or a characteristic approaching the ideal single sheet characteristic in the form of a target characteristic (ZK) between the output voltage ( $U_A$ ,  $U_Z$ ) at the output of the evaluating device and the gram weight or weight per unit area, for detecting single, missing or multiple sheets.

38. Device according to claim 37, characterized in that the evaluating device (4) as a correction characteristic (KK) for papers and similar materials is supplied with a characteristic of the input voltage ( $U_E$ ,  $U_M$ ) of the measuring signal mirroring the ideal or

thereto approximated target characteristic (ZK) for the purpose of single sheet detection.

39. Device according to claim 37, characterized in that the evaluating device (4) is supplied as a correction characteristic for papers and similar materials with a characteristic of the measuring signal input voltage ( $U_E$ ,  $U_M$ ) mirrored on the ideal or thereto approximated target characteristic for single sheet detection, following cartesian coordinate transformation relative to the connecting line of the two end points of the measuring value characteristic for the material spectrum to be detected.

40. Device according to one of the claims 37 to 39, characterized in that the correction characteristic is chosen in such a way that the characteristic of the input voltage ( $U_E$ ,  $U_M$ ) of the measuring signal is transformable into the target characteristic over a wide gram weight or weight per unit area range, particularly between 8 and 4000 g/m<sup>2</sup>.

41. Device for the contactless detection of flat objects, particularly in sheet form, such as multilaminated materials adhesively applied to base or support material, e.g. labels, splice, break or tear-off points and similar flat materials, relative to the presence or absence thereof, with at least one sensor device (10) having at least one transmitter (T) and associated receiver (R), the flat objects to be detected being placed in the beam path between transmitter (T) and receiver (R), the receiver (R) receiving as a measuring signal the radiation transmitted through the flat objects or the radiation obtained in the absence thereof and with a downstream evaluating device (4) to which is supplied the measuring signal ( $U_M$ ,  $U_E$ ) for generating a detecting signal, particularly for performing the method according to one of the claims 1 to 36, characterized in that to the evaluating device (4)

connected to receiver (R) is supplied at least one correction characteristic (KK) in such a way that the correction characteristic (KK) transforms the characteristic of the input voltage ( $U_E$ ,  $U_M$ ) of the measuring signal from receiver (R) as a function of the gram weight or weight per unit area of the flat objects to target characteristic (ZK) in such a way that it is possible to produce a linear or almost linear characteristic with finite gradient, particularly a characteristic having a maximum gradient in the gram weight range to be detected, as an ideal target characteristic (ZK) or a target characteristic approximating said ideal target characteristic between the output voltage ( $U_A$ ,  $U_U$ ) at the output of the evaluation and the gram weight, or the weight per unit area, for detecting the presence or absence of flat materials.

42. Device according to claim 41, characterized in that the correction characteristic (KK) for labels and similar materials can be produced by mirroring the characteristic of the input voltage ( $U_E$ ,  $U_M$ ) of the measuring signal on the ideal label detection target characteristic (ZK) in the gram weight or weight per unit area range to be detected.

43. Device according to claim 41, characterized in that the correction characteristic (KK) for labels and similar materials can be produced by mirroring the characteristic of the input voltage ( $U_E$ ,  $U_M$ ) of the measuring signal on the ideal target characteristic (ZK) in the gram weight or weight per unit area range to be detected for label detection purposes following cartesian coordinate transformation relative to the connecting line of the two end points of the measuring value characteristic for the material spectrum to be detected.

44. Device according to one of the claims 41 to 43, characterized in that the correction characteristic for labels or similar materials is chosen in such a way that the characteristic of the measuring signal input voltage ( $U_E$ ,  $U_M$ ) is transformable to the target characteristic over a gram weight or weight per unit area range of approximately 40 to 300 g/m<sup>2</sup>.

45. Device according to one of the claims 41 to 44, characterized in that the target characteristic (ZK) for labels and similar materials has a maximum, constant negative gradient and a maximum voltage difference relative to changes in the gram size, particularly over a weight per unit area range of approximately 40 to 300 g/m<sup>2</sup>.

46. Device according to one of the claims 37 to 45, characterized in that the evaluating device (4) has at least one amplifying device (5) and that the amplifying device (5) is supplied with at least one correction characteristic (KK) for producing the target characteristic (ZK) at the output of the amplifying device.

47. Device according to one of the claims 37 to 46, characterized in that the evaluating device (4) has an analog-digital converter means for converting the receiver measuring signal and that an evaluating device (6) for the subsequent or direct digital evaluation of the converted measuring signal by means of a correction characteristic (KK) is provided for generating a detection signal.

48. Device according to one of the claims 37 to 47, characterized in that the correction characteristic is built up as a single characteristic or as a continuous or zonal combination of several different correction characteristics over the entire gram weight or weight per unit

area range or portions thereof.

49. Device according to one of the claims 37 to 48, characterized in that the correction characteristic is designed as a linear or nonlinear characteristic, as a single or multiple logarithmic characteristic, as an exponential characteristic, as a hyperbolic characteristic, as a polygonal line, as a random degree function, or as an empirically determined or calculated characteristic, or as a combination of several of these characteristics.

50. Device according to one of the claims 37 to 49, characterized in that the correction characteristic is designed as a logarithmic or multiple logarithmic or similar nonlinear characteristic combined with an approximately linear or exponentially or similarly rising characteristic or amplification.

51. Device according to claim 37, characterized in that as the correction characteristic for papers and similar materials is provided a suitable characteristic for obtaining the ideal or approximately ideal target characteristic, particularly an inverse or almost inverse characteristic to the characteristic of the measuring signal input voltage ( $U_E$ ,  $U_M$ ).

52. Device according to one of the claims 37 to 51, characterized in that the correction characteristic (KK, 23) is fixed impressed, given in material-specific manner or regulated dynamically, particularly in microprocessor-controlled manner.

53. Device according to one of the claims 37 to 52, characterized in that, with respect to the single, missing or multiple sheet, the evaluating device (4) is provided with at least two thresholds in the form of an upper and lower threshold and when the incoming measuring signal is greater than the upper threshold, this is detected as a "missing sheet", when the incoming measuring signal is between the thresholds this is detected as a "single sheet" and when the incoming measuring signal is smaller than the lower threshold, this is detected as a "multiple sheet".

54. Device according to claim 53, characterized in that the thresholds, particularly the detection threshold or threshold for multiple sheets are designed so as to be set in fixed manner or dynamically carried along.

55. Device according to one of the claims 37 to 54, characterized in that particularly in the case of labels, splices and break points, as well as tear-off threads, said objects are passed between transmitter and receiver and as a function of the specific object measuring signal received in automatic or externally triggered manner the object-specific switching threshold can be determined relative to the target characteristic.

56. Device according to one of the claims 37 to 55, characterized in that the sensor device (10) has at least one ultrasonic sensor or one or more optical, capacitive or inductive sensors.

57. Device according to one of the claims 37 to 56, characterized in that the transmitter (T) and receiver (R) of the sensor device are mutually oriented, particularly coaxially, in the main beam axis of the radiation used and that the main beam axis is oriented substantially perpendicular or under an angle to the plane of the flat objects (2) arranged between transmitter (T) and receiver (R) or moved relative thereto.

58. Device according to one of the claims 37 to 57, characterized in that the evaluating device (4) has several, particularly parallel-connected amplifying devices (21, 22), whose output signals are combined for target characteristic (23).

59. Device according to one of the claims 37 to 58, characterized in that the operating mode of the sensor device (10) can be transformed from pulsed operation to continuous operation and vice versa.

60. Device according to one of the claims 37 to 59, characterized in that in continuous operation the transmitting signal has phase jumps or short interruptions.

61. Device according to one of the claims 37 to 60, characterized in that the transmitting signal is frequency-modulated.

62. Device according to one of the claims 37 to 61, characterized in that there is an auto-balancing device or a device for setting the transmitting frequency and/or transmitting amplitude with respect to the receiver signal is provided.



63. Device according to claim 62, characterized in that auto-balancing can be performed in times synchronized with the transmitting frequency or in defined pause periods.

64. Device according to one of the claims 37 to 63, characterized in that the spacing between transmitter (T) and receiver (R), particularly of the sensor heads, can be varied as a function of the application.

65. Device according to one of the claims 37 to 64, characterized in that there is a feedback device between the evaluating device (4), particularly a microprocessor (6) and sensor device (10).

66. Device according to one of the claims 37 to 65, characterized in that the evaluating device (4) has several specific channels for the detection of different flat objects, such as double sheets or labels, that different correction characteristics are impressed on the channels and that there are multiplexers (34, 35) for controlling the inputs and outputs of the channels for producing an overall target characteristic.

67. Device according to one of the claims 37 to 66, characterized in that the transmitter is provided below the sheets or flat objects to be detected and the receiver above the same and that the transmitter head has a limited spacing from the sheet.

68. Device according to one of the claims 37 to 67, characterized in that between the transmitter (T) and the elongated object (2) to be detected there is at least one pinhole diaphragm and/or slit diaphragm and/or lens for improving the spatial resolution in the case of ultrasonic or optical sensors.

69. Device according to claim 68, characterized in that the arrangement of the diaphragms and/or lenses takes place transversely to the movement direction of the scale-like, flat objects, or that the arrangement of the diaphragms and/or lenses takes place longitudinally to the movement direction of the multiple layers adhesively applied to a base or support material, or that in particular the slit diaphragms and/or lenses are positioned in the thread running direction for detecting elongated objects adhesively applied to the base or support material, such as e.g. material and tear-off threads.

70. Device according to one of the claims 68 or 69, characterized in that elongated objects (2) introduced between transmitter (T), receiver (R) and the diaphragm float as close as possible over the diaphragm or slidingly contact the latter.